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Framing financial incentives to promote hypertension care among rural primary doctors in Shandong Province, China: study protocol of a randomized field trial

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Abstract

Background Managing hypertension in rural China poses significant challenges, as rural physicians often struggle to provide consistent, high-quality care. Insufficient financial incentives may explain the sub-optimal long-term treatment behavior by rural doctors. This study designs a protocol for studying better-framed financial incentives for rural physicians to manage hypertension treatment, specifically the impact of loss-framed versus gain-framed incentives in enhancing hypertension management.

Methods This protocol outlines a three-arm randomized controlled trial to be conducted in rural China. A total of 300 primary doctors, involving 1,500 hypertension patients, will be randomly assigned in a 1:1:1 ratio to two intervention groups or a control group. Financial incentives will be implemented in the two intervention groups, namely gain-framed incentives and loss-framed incentives. The trial will include a six-month intervention period followed by six months of follow-up. Changes in patients' blood pressure (BP) values include both systolic and diastolic BP, hypertension control rates, physicians' hypertension care performance and patient medication adherence will be measured. Data collection includes baseline information and regular blood pressure measurements.

Discussion This study will determine the effectiveness of a 6-month framing financial incentive intervention in improving doctors' hypertension management and patients' blood pressure control outcomes while comparing the different effects of loss framing and gain framing.

Trial registration Chinese Clinical Trial Registry (ChiCTR) ChiCTR2300077733, Date registered: 07/11/2023.

Keywords Hypertension care, Financial incentives, Framing, Randomized controlled trial

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Background

Hypertension is a global public health challenge. Hypertension, and its complications, including heart disease, stroke, and kidney disease, have high disability and mortality rates, leading to a high cost on healthcare budgets and a financial burden on families [1].With the acceleration of aging in China, the prevalence of hypertension is increasing [2]. A nationwide survey conducted in 2018 reported that only 41% of hypertension patients in China were aware of their condition, 34.9% were taking anti-hypertensive medications, and only 11% had their blood pressure under control, a figure that is relatively low compared to high-income countries. Hypertension prevalence was lower in rural areas (39% awareness, 32.4% treatment, and 8.5% control) than in urban areas (43.1% awareness, 37.5% treatment, and 13.6% control) [3]. Hypertension is a serious public health challenge, especially in rural China. Improving hypertension care is urgently needed and of great importance.

Controlling blood pressure and lowering the risk of complications frequently requires ongoing treatment over the long term. Self-management behaviors like regularly taking medication, eating healthy, and exercising are crucial for controlling hypertension [4–9]. However, patients with hypertension often experience difficulties with both poor compliance and insufficient blood pressure management, contributing to overall healthcare burden and strain on healthcare systems [10, 11]. Evidence suggests that without physicians' intervention, hypertensive patients often fail to achieve appropriate self-monitoring and treatment [12–14]. Clearly, effective professional medical intervention is crucial in managing hypertension, particularly for patients who struggle with self-management.

As public health gatekeepers, rural family doctors in community and township health centers, including Village Health Clinics, Township Health Centers and County Hospitals, play a vital role in controlling and preventing hypertension among rural patients [15, 16]. But, there are several issues with family doctor services in rural areas, including poor service quality, low patient satisfaction, and unsatisfactory chronic disease control outcomes [17–19]. Characterized by low pay, the remuneration system for primary care physicians in rural China has insufficient financial incentives [20–22]. As a result, there are too few doctors, too poorly paid and too often struggling to provide consistent, high-quality chronic disease monitoring, adequate long-term follow-up, good service quality, and effective hypertension management. These issues have sparked increasing interest in how financial incentives can improve healthcare services, particularly to enhance hypertension management in rural China.

Financial incentives change the behavior [23–25]. Most existing research on the impact of financial incentives in managing chronic diseases, such as hypertension, has taken a mainly patient perspective [26, 27]. Evidence indicates that financial incentives can promote healthy behaviors, such as physical activity and monitoring adherence [28, 29]. The effectiveness of financial incentives on physician behavior has been validated in many studies. Specifically, the points of interest in the physician behavior literature lie in payment methods, treatment behavior and physician altruism [30–37]. Previous studies also found that financial incentives at the physician level can contribute to better blood pressure control. For example, providing financial incentives to physicians can be more effective than solely incentivizing patients in the hypertension care [38] and financial incentives for individual physicians are more effective than group incentives [39]. However, the question of how different framing of financial incentives affects physician behavior in hypertension care remains under-explored in the current health economics literature. By drawing on prospect theory in behavioral economics as the theoretical lens, we address this gap in the literature by investigating how the framing of financial incentives can influence rural primary care physicians' hypertension management practices. This approach provides a novel perspective and adds to existing literature, highlighting the potential of incentive design in improving healthcare outcomes, particularly in managing chronic diseases, such as hypertension.

From prospect theory, individuals derive utility from gains and losses, and individuals are much more sensitive to losses (loss-aversion)—even small losses—than to gains of the same magnitude [40, 41]. Existing research has shown that the framing effect operates through different mechanisms under different types of loss or gain framing incentives [42, 43]. Health management research found that gain-framed incentives are more effective, indicating that loss aversion is a context-dependent tendency with boundary conditions instead of a ubiquitous phenomenon [44, 45]. In the current health economics literature, framed financial incentives, particularly loss-aversion incentives, have not been sufficiently explored in relation to hypertension care behaviors among rural primary care doctors. Utilizing concepts in behavior economics, such as loss aversion and anchoring, we examine how different loss framing versus gain framing financial incentives can influence rural physician behavior. Researching the impact of loss and gain framing on doctors' behavior in chronic disease management is crucial, particularly in long-term health management. As behavioral economics reveals the significant influence of decision framing [46, 47], doctors managing conditions like hypertension may face complex decision-making

situations, influenced by cognitive biases and psychological factors. The gain frame motivates doctors by offering potential rewards for meeting treatment goals, but doctors may perceive these rewards as an additional benefit. In contrast, the loss frame leverages loss aversion by making doctors lose rewards if they fail to meet goals, prompting stronger motivation to avoid the loss. Understanding these framing effects helps design more effective financial incentives, optimizing doctors' treatment behaviors and improving the management of conditions like hypertension, ultimately enhancing patient health outcomes.

We will conduct a randomized field experiment to investigate the impact of framing financial incentives on hypertension management by rural doctors. In this trial, physician subjects will receive financial incentives for specific actions, including adherence to established clinical guidelines for hypertension management, ensuring timely follow-up appointments with patients, and maintaining accurate and comprehensive documentation of patient care. In addition, physicians will be rewarded based on patient outcomes, particularly the achievement of controlled blood pressure. The financial incentives will be administered using two distinct framing strategies: a gain-framing approach, which rewards successful performance, and a loss-framing approach, which imposes penalties for not meeting the set targets. Specifically, we shall investigate two key aspects: first, the effectiveness of financial incentives by assessing how financial incentives enhance measurable improvements in patients' blood pressure levels and adherence to treatment protocols and, second, a comparison of the effectiveness of loss-framed versus gain-framed incentives in improving hypertension management.

Methods

Study design

We specify a three-arm, randomized controlled trial (RCT) designed to improve the quality of hypertension care by doctors in rural areas. The key elements involve framed financial incentives, including loss-framed incentives and gain-framed incentives. The study proposes sampling 300 primary care physicians and 1,500 hypertension patients over 12 months, comprising a six-month intervention period and a six-month follow-up assessment period. The study procedure is shown in Fig. 1.

Recruitment and procedure

Eligible participants will be recruited from Shan County in Shandong Province, China, where rural hypertension prevalence is estimated at 43.8% [48]. The primary healthcare system of this county is composed of several county hospitals and 22 township hospitals. To strengthen the management of chronic diseases such as hypertension, Shan County has established Chronic Disease Management Centers (CDMC) in collaboration with the county hospitals and township health centers. At the county level, CDMCs are based in two county hospitals, employing approximately 900 physicians. At the township level, sub-CDMCs operate within 22 township health centers, collectively employing around 600 physicians. At the clinic level, there are 345 village health stations, each staffed with 1–2 primary care physicians. We will recruit 300 eligible primary care physicians and 1500 patients from these CDMCs.

We establish inclusion and exclusion criteria. Following consent, patient participants will complete a detailed questionnaire and undergo a comprehensive physical examination, including baseline blood pressure measurement. Physician subjects will be randomly assigned to two intervention groups or a control group, and each physician will be randomly assigned five patients. Physician subjects in the intervention groups, but not the control group, will receive a six-month framed financial incentive. After the intervention phase, all participants will undergo a six-month follow-up period, during which additional assessments will be conducted. Data on blood pressure, symptoms, and other relevant indicators will be systematically collected and analyzed to evaluate the effectiveness of the intervention.

Study population

We plan to recruit 300 rural primary doctors from the CDMCs in Shan County, who will voluntarily enroll in the study and sign an informed consent form. Licensed physicians who work full-time in rural hospitals and clinics are eligible to participate. Physicians who have plans to leave the hospital or practice within one year will be excluded. Participating doctors' supervisors or other hospital officials will not influence their decision to participate in the study or access their performance data.

Fifteen hundred (1500) hypertension patients will be recruited from CDMCs. The target patients in our study will be aged 45 and above, as research indicates that the risk of developing hypertension significantly increases starting at this age [49]. The inclusion criteria for patients will be: (a) age from 45 to 75 years; (b) patients with clinical-diagnosed essential hypertension (SBP/DBP ≥ 140/90 mmHg[1]); and (c) local residents who have been living in the city over one year. The exclusion criteria for patients will be: (a) a clinical-diagnosed stroke, myocardial infarction, heart failure, malignancy, regular kidney dialysis, or end-stage renal disease; (b) a history of secondary hypertension diagnosed by a physician; and (c) plan to move out of residence within a year.

[1] According to the definition of hypertension in the Chinese Guidelines for the Prevention and Treatment of Hypertension.

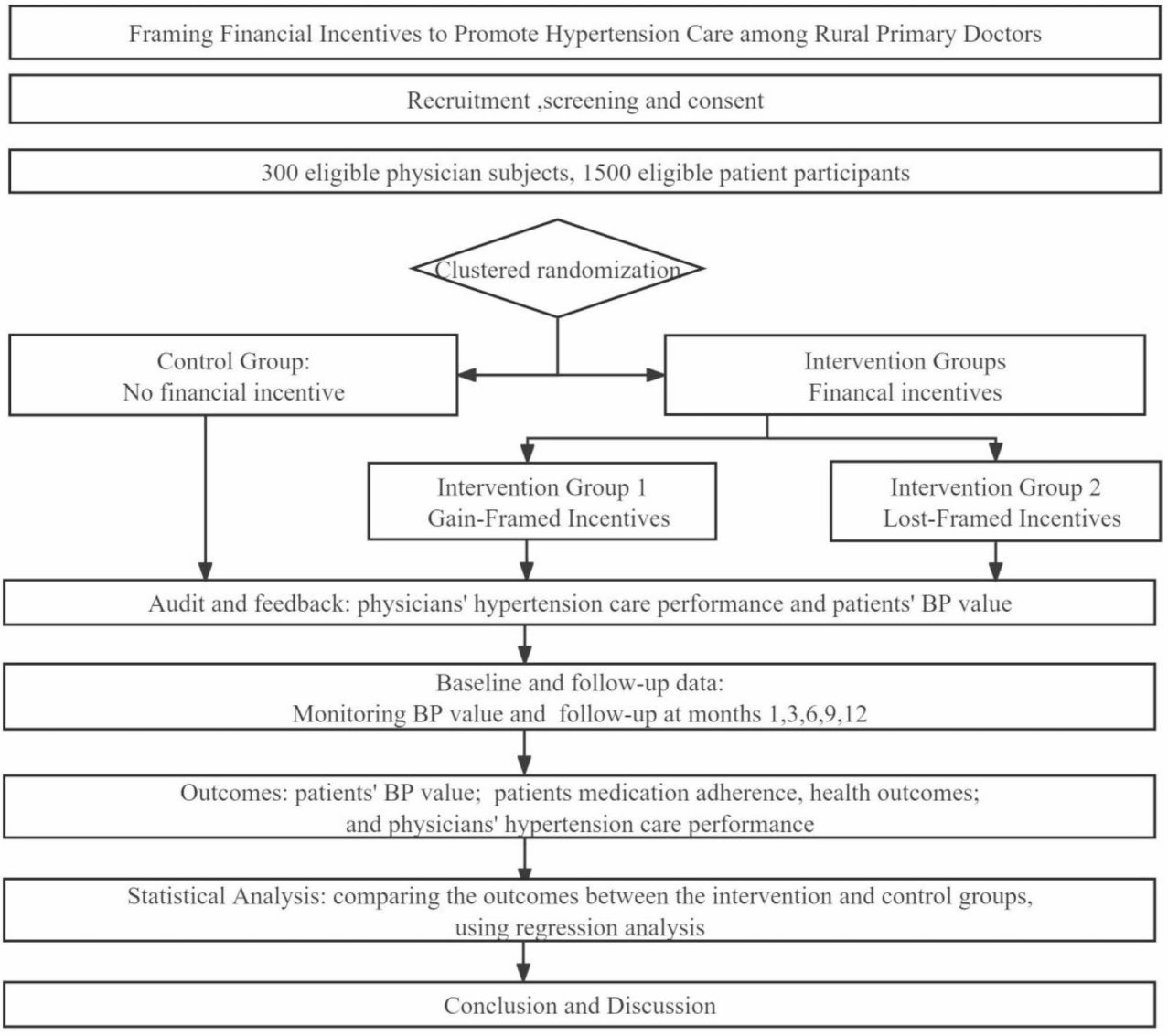

Fig. 1 Flow diagram of the study

The experimental procedure will ensure participant anonymity. Each participant will be assigned a unique identification number, which will be used to track their data throughout the study. The personal identity of participants will be kept separate from their data, and all identifying information will be removed to maintain confidentiality. Only authorized personnel will have access to the key linking identification numbers to participants' personal information.

Randomization and blinding

Each eligible physician participant, along with their five patient participants, will be randomly assigned to one of two intervention groups or a control group in a 1:1:1 ratio. This means that each group will consist of 100 physicians and 500 patients, with each physician paired with five patients. Randomization will be conducted at the clinic level. A computer-generated process will then randomly assign clinics to the intervention or control group. Physicians will be randomized first, and each physician's five patient participants will then be randomly allocated to the corresponding intervention or control group, ensuring consistency within physician-patient pairs.

The randomization will be performed using a computer-based system, which will automatically generate a unique study ID for each physician and their five patients. The computer system will assign participants to the appropriate group, maintaining the integrity of the random allocation process and ensuring that each participant's group assignment is kept confidential.

Due to the behavioral nature of the intervention, neither the physicians, patients, nor principal investigators

will be blinded to the participant allocation. However, all assessors involved in follow-up assessments and data collection will be blinded to the group assignments. This ensures that assessors are unaware of whether participants belong to the intervention or control group during the entire follow-up period, preventing any potential bias in data collection and evaluation.

Sample size

Based on sample size selection for studies with repeated measures, we calculated that 246 physician-patient clusters are required. Following findings from previous research on relevant interventions and outcomes, the effect size (f) was assumed to be 0.35 [50, 51]. This calculation targets 80% statistical power with a significance level of 0.05. While we primarily focused on estimating sample size for repeated measurements, additional factors such as potential time effects and clustering of patients within physicians were considered. Each physician will manage five patients, meaning that both physician- and patient-level factors were considered in the sample size calculation. Considering possible unexpected drop-out rate, we have increased the sample size to 300 physician-patient clusters, including 300 physicians and 1,500 patients in total.

Intervention

After participants complete the baseline survey, they will start a six-month intervention followed by a six-month follow-up. Figure 2 shows that the framing financial incentives include gain-framed incentives and lost-framed incentives.

Intervention group 1: Gain-framed incentives

The incentive group will use financial incentives to encourage rural physician adherence to hypertension guideline, with the gain frame emphasizing potential rewards for meeting the treatment goals. According to the Chinese Hypertension Guideline [52], primary doctors should assess the health state of hypertensive patients through physical examination, blood pressure monitoring, lifestyle recommendations and guideline-recommended medication adjustment disease risk warning. Regular monitoring and evaluation should be provided for each hypertensive patient by participating physicians at least once every three months. A reward of RMB20 per participant will be given when doctors wholly and accurately document the regular monitoring and evaluation every three months.

In intervention group 1, we also use financial incentives for the outcome of blood pressure management. A reward of RMB20 will be given to the physician participant if the patients' BP value achieves our hypertension management targets (average daytime SBP decreased by 10mmHg or average daytime SBP/DBP < 140/90 mmHg).

As mentioned above, when the goals are achieved, subjects in Intervention Group 1 will receive financial rewards. Subjects will receive rewards at the end of every three months in the intervention period. A maximum of RMB400 will be awarded to each physician during the six-month intervention period. The RMB400 (US$55) incentive for five patients, or RMB80 (US$11) for each patient over six months, is roughly twice the health authorities yearly per patient financial subsidy standard for basic public health services of RMB94 (US$13).

Intervention group 2: lost-framed incentives

In contrast to intervention group 1, lost-framed incentive physicians will be informed that there is a full pot with RMB200 at the beginning of each three-month intervention. However, RMB20 would be deducted from the pot for every goal failure, such as missing follow-up or uncontrolled BP value. One intervention period will last for three months. This study includes two three-month intervention periods, totally six months of intervention. When the goals are achieved, the participants will not lose. As shown in Fig. 2, the maximum financial incentive amounts are the same as in the gain-framed intervention group 1, and the incentive targets in both groups are consistent, encompassing both physicians' hypertension management behaviors and patients' blood pressure control. Both rewards will be distributed to subjects at the end of every three months in the intervention period.

Control group

Participants in the control group will receive no intervention

Given expertise within the research team, we will develop a closed management app exclusively for internal team use, applicable only to this trial. To ensure that all participating physicians can effectively use the app, we will design the interface to be as simple and user-friendly as possible. Before the trial begins, we will provide training sessions for both physicians and patients on how to use the app. Throughout the study, participants will have access to support staff who can assist with any app-related issues, ensuring that they can use the app smoothly. The app will allow doctors to record their activities in blood pressure management, monitoring, and medication guidance for patients. Additionally, after each follow-up, patients will use the app to view the doctor's follow-up records and communications, as well as their own blood pressure readings, then verify whether these records align with the actual monitoring results. This way, we obtain more accurate data on the physicians' hypertension management behaviors through patient feedback.

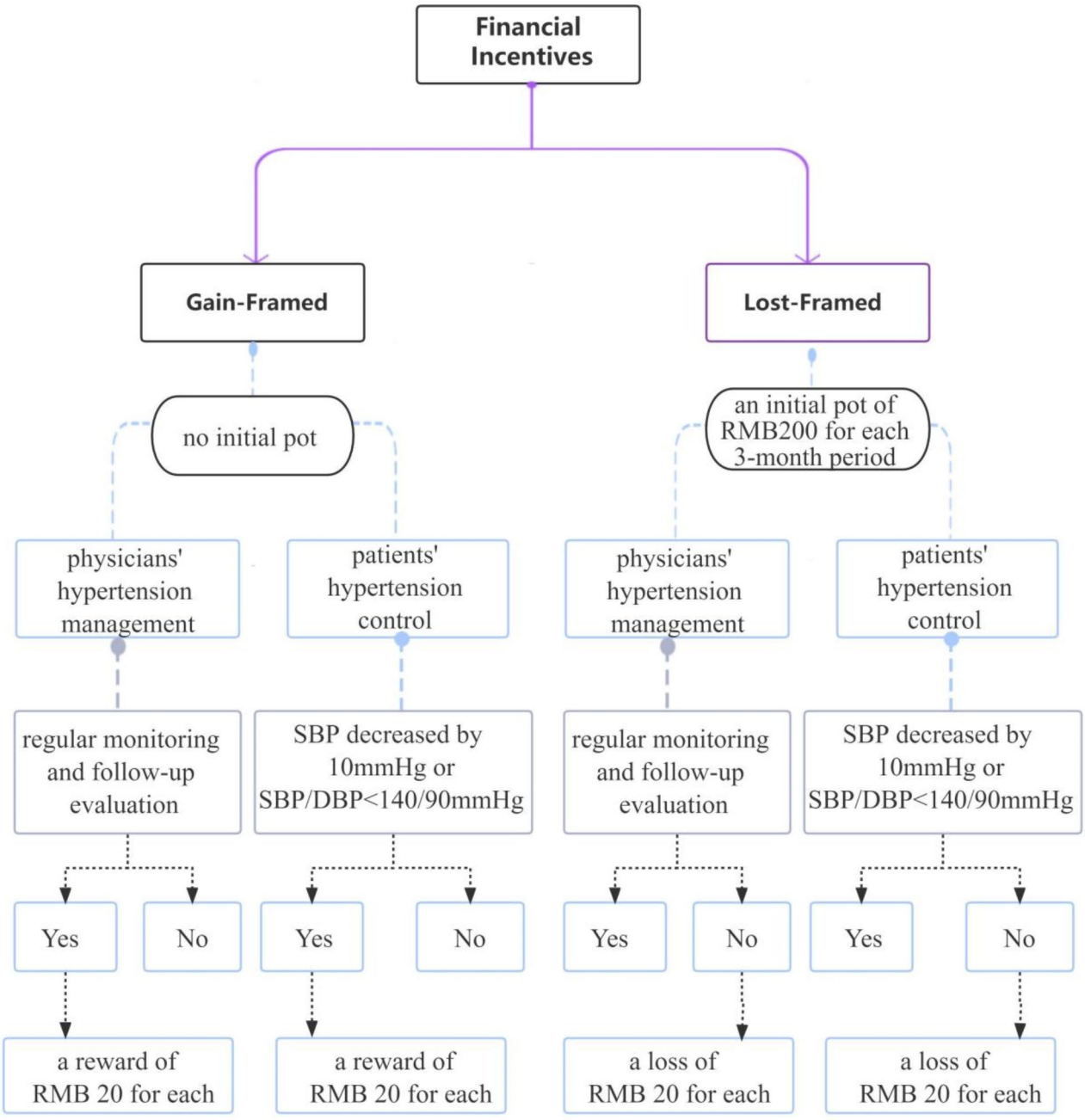

Fig. 2 Framing financial incentive

Patient information will be strictly confidential, with full respect for participant privacy. The app will also include a patient-facing component, enabling patients to record their own blood pressure monitoring results and medication adherence, and view the relevant guidance and advice provided by their doctors. All patient data will be encrypted during storage and transmission, and will comply with applicable privacy protection regulations (such as GDPR) to ensure data security.

Study outcomes

Although randomization and financial incentives will be done at the clinic level, the analysis will be mainly conducted at the patient level for primary and secondary outcomes. The primary outcome is changes in patients' systolic and diastolic BP values. Secondary outcomes are: (a) the proportion of hypertension control (average daytime SBP/DBP < 140/90 mmHg); b) physicians' hypertension care performance, including clinical guidelines adherence, medical guidance, lifestyle modification

Table 1 Measurement timeline and variables for study participants

	Data collection schedule					
		Baseline	Intervention and follow-up period Follow-up			
		T0	3month-T1	6month-T2	9month-T3	12month-T4
Physician Subjects	**Baseline Measurements**					
	Demographic characteristics	√				
	Career status	√				
	Economic status	√				
	Hypertension Care Performance					
	Clinical guidelines adherence		√	√	√	√
	Medicational guidance		√	√	√	√
	Lifestyle modification counseling		√	√	√	√
	Frequency of educational interaction		√	√	√	√
	Follow-up visits		√	√	√	√
	Referral and specialist consultation		√	√	√	√
Patient participants	**Baseline and Social Measurements**					
	Demographic characteristics	√				
	Income	√				
	Health insurance	√				
	health provider distance	√				
	health provider choice	√				
	Health status					
	BMI	√	√	√	√	√
	Chronic conditions	√	√	√	√	√
	Mental health	√	√	√	√	√
	Lifestyle habits	√	√	√	√	√
	Medication history	√	√	√	√	√
	Physical Examination	√	√	√	√	√
	Blood and urine examination	√				√
	Hypertension related outcome					
	Blood pressure (SBP/DPB)	√	√	√	√	√
	Atherosclerosis Tests	√		√		√
	Incident CVD events	√		√		√
	Medicational adherence	√	√	√	√	√
	Patient Satisfaction Survey					
	CAHPS Clinician & Group Survey	√	√	√	√	√

counseling, frequency of educational interaction, regular monitoring and evaluation status, referral and specialist consultation; c) patients' self-reported medication adherence; and d) health outcomes, including BMI, physical functioning, mental well-being, and the blood tests related to blood pressure.

Data collection and management

The physician participants will be given a baseline survey with questions on demographic characteristics, income, certificate, years of practice, professional satisfaction. The assessors with nursing qualifications who are blind to the randomization will measure the patients' BP every three months in the standard way. Structured questionnaire surveys will be conducted among patient participants at the baseline and then follow-up visits. The study of patients includes questions on demographic characteristics (sex, age, family size, education), income, health insurance, health provider distance, and health provider choice, health status (height, weight, chronic conditions, mental health, CVD events), lifestyle habits (eating habits, smoking, alcohol consumption, physical behavior), hypertension (time and place of diagnosis, monitoring behaviors, related cognitions), medication adherence, and patients' satisfaction with primary doctors' management of hypertension. Details on the specific data collection measures and time points are outlined in Table 1.

Investigators will undergo comprehensive training before the trial to ensure standardized data collection methods. Each participant will receive a unique code, ensuring accurate identification and data anonymity. A quality control specialist will meticulously review the data from the epidemiological questionnaire and clinic

examination. To reduce the risk of loss to follow-up, we will conduct centralized blood pressure measurements at nearby township hospitals by researchers. Patient subjects will receive a baseline participation bonus of RMB20 and a transportation subsidy of RMB10 for each follow-up visit.

Statistical analysis

We will compare the summary statistics among different groups using the baseline and follow-up data. Once the summary statistics are analyzed, we undertake pairwise comparisons using Repeated-Measures ANOVA between the control and intervention groups. Specifically, we will compare (a) control versus lost-framed incentives; (b) control versus gain-framed incentives; and (c) lost-framed incentives versus gain-framed incentives. These comparisons will investigate the effectiveness of framing financial incentives on hypertension care versus control.

Second, the impact of hypertension care outcomes will be assessed through mixed-effects regression analysis, which is essential in this trail to account for the complex data structure, including repeated measurements from the same participants and variations across different physicians or clinics. This approach allows for the estimation of both fixed effects (such as the intervention group and time) and random effects (such as differences between physicians or clinics), providing a more accurate understanding of the intervention's impact while controlling for potential confounders like age, sex, and baseline health status. Additionally, we will perform robustness checks and sensitivity analyses by incorporating additional social variables, including the availability of health insurance, health provider distance, and health provider choice, to ensure the stability of our results under various model specifications.

Discussion

This proposed study is a randomized field trial aimed at investigating how the framing of financial incentives influences rural physicians' behavior in hypertension management. Specifically, the study aims to explore the effects of gain-framed and loss-framed financial incentives on doctors' hypertension care practices and patients' blood pressure control. Based on the incentive scheme, the study is expected to show improvements or maintenance in both primary and secondary outcomes, such as changes in and control of blood pressure among hypertensive patients, as well as physicians' performance in hypertension management. The protocol will provide a foundation for future research aimed at enhancing doctors' hypertension management practices, reducing the risk of hypertension-related complications, and promoting the integration of this approach into rural healthcare services in China. Additionally, our intervention has the potential to address the issues of insufficient incentives for primary doctors in rural areas and the problem of adherence among hypertensive patients. By examining how the framing incentives influence physicians' actions, the study seeks to provide insights into the effectiveness and potential limitations of using financial incentives as a strategy to improve hypertension care and hypertension control.

Behavioral economics has increasingly informed the development of effective incentive schemes designed to promote high-value care [53, 54]. Research in this field demonstrates that the structure and delivery of incentives—when aligned with behavioral insights—can significantly shape decision-making [55, 56]. While these principles, including inertia, loss aversion, choice overload, and relative social ranking, have been successfully applied to personal health decisions, retirement planning, and savings behavior [57, 58], they have been largely overlooked in the design of physician incentive programs. The findings of this study are expected to yield several implications. First, our results will inform policymakers and healthcare organizations about designing and implementing incentive programs to encourage guideline-recommended care for hypertension. Understanding how different framings of financial incentives impact physicians' behavior can help make these programs more effective and efficient. The study should provide insights into healthcare professionals' psychology and decision-making processes and help identify factors that influence their adherence to treatment guidelines. Ultimately, the study's findings will help improve hypertension management strategies and contribute to the overall goal of improving patient outcomes in hypertension management, especially through the cost-effectiveness analysis of the incentive in the future.

This study will encounter three main challenges and difficulties. While collaborating with CDMCs to recruit 300 primary care physicians and 1,500 patients, the study must maintain physician and patient independence from hospital officials. To address this issue, CDMCs will be required to provide only existing lists of physicians and patients, with recruitment conducted exclusively by the research team, keeping the identities of potential participants confidential. Further, all physician data will be managed solely by our research team to preclude any potential interference. Second, we may face the challenges of insufficient physicians' participation. To address this issue, we will increase physician engagement by offering participation incentives, emphasizing the clinical significance of improved patient blood pressure management, linking participation with customer care and leveraging our university-based research background to enhance trust. Third, when collecting hypertension care data via the app, there is a risk that physicians may

manipulate data to maximize incentive payouts. To mitigate this risk, the study will implement stringent data monitoring and validation protocols, including regular audits, cross-checks, telephone follow-ups, and random verifications, to ensure the accuracy and integrity of the data. Additionally, we will integrate the app with blood pressure monitors to enable automatic data uploading and location tracking of measurements, reducing the possibility of manual data manipulation. Although these challenges are inherent to the study design, the implementation of rigorous recruitment and oversight procedures is anticipated to attenuate bias and to enhance both the credibility and the practical relevance of the study outcomes.

The study has several potential limitations. First, the study will be conducted in rural areas, which may limit the external validity of the findings and make it difficult to generalize the results to urban. Second, the six-month assessment period will limit our understanding of the long-term effects of the intervention that will extend longer than 6 months. Future research will need to address urban primary care of hypertension and long-term impact of hypertension interventions. Future studies could consider a cross-design approach, where one group is initially assigned to receive gain-framed incentives for six months followed by loss-framed incentives, and another group receives them in the reverse order.

Abbreviations

RCT	Randomized Controlled Trial
CDMC	Chronic Disease Management Centers
BP	Blood Pressure
BMI	Body Mass Index
CVD	Cardiovascular Disease
GDPR	General Data Protection Regulation

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Author contributions
YZ, JW, JLT conceptualized the study. PYF, JW contributed to the grant application. YZ, JW, PYF contributed to the study design and substantively revised the manuscript. EM, SN, YWQ, DJK, ZHM contributed to the development of study methodology and participated in the revision of the protocol. All authors reviewed the manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Primary ethics approval has been received from the Wuhan University Human Research Ethics Committee (WHU-HSS-IRB2023014). Consent will be collected from all participants.Informed consent will be obtained from all participants, and participation will be voluntary. Participants may withdraw from the study at any time without facing any negative consequences. Personal data will be kept confidential. Findings from the study will be published in peer-reviewed journals and presented at national and international conferences. The whole study will strictly follow the ethical guidelines stipulated by the Helsinki Declarations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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